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ABSTRACT

Teacher training projects have used university research scientists to conduct workshops for teachers, but because of faculty time constraints and university reward systems, it is unlikely this type of program will be used extensively. This project utilized community college professors whose main focus is teaching science and working with the public school systems. The purpose of the reported study was to examine, qualitatively, the personal development of four professors in conducting an academy for science teachers. From interviews with the professors the following conclusions were made: (1) the professors initially felt the elementary and secondary schools were lacking in the teaching of scientific concepts; (2) after experiencing success and change through the academy, the professors feel they are now an integral part in the development of student's perceptions of science, attitudes toward science, and understanding of scientific concepts; and (3) they feel the need to be teaching in a fashion that is also motivating and nurturing of positive attitudes toward science. (PR)

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The Professional Development of College Science Professors as Science Teacher Educators

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The Professional Development of College Science Professors as Science Teacher Educators

Introduction

The National Science Foundation in the summer of 1992 funded a program for the Comprehensive Regional Center for Minorities (CRCM) which operated and sponsored a life science academy for K-12 teachers. The academy was designed to enhance teachers' knowledge of biological concepts and instructional methods for science teaching. The academy was divided into two sections, one for elementary teachers and the other for secondary teachers.

The instructors for the academy were on the faculty of the community college where the academy was held. They all had doctoral degrees in some area of life science (one in vertebrate ecology, one in cell and molecular biology, one in biology, and one in zoology). Even though all four professors have had extensive research experience and are currently actively conducting research in their respective fields; as community college professors their primary responsibility is teaching and thus they are a good resource to the school systems and to teacher education.

Other teacher training projects have used university research scientists to conduct workshops for elementary and secondary teachers, for example, the physicist Letterman in Chicago and the biologist Paul Saltman in California (Barinaga, 1992). Such programs have been very helpful but it is unlikely that this type of program will ever be extensively used across the country. Research university scientists are constrained both by the time required by their research and by the reward systems of research universities which value scholarly activity above teaching. Therefore, university professors who devote themselves to do teacher training tend to be senior professors who are beyond requirements for tenure, and their numbers are few.

This model project differs from those eliciting assistance of research university scientists in two ways. First, this model project utilized community college professors whose main focus is teaching science and working with the public school systems. Second, the professors were provided with funds and a structure to find out about science teaching in the schools and teachers at the elementary and secondary level.

Three of the professors conducting the academy were male and one was female. They had been teaching at the college level from six to twenty years. These community college professors all had concerns about science education but lacked direct experience in K-12 teacher education. Like many scientists, they had concerns about the quality of K-12 science education. The professors all believed that if they

could develop a better understanding of science education at the elementary and secondary levels, they could be more responsive to their own students, especially those aspiring to a career in education. Given the opportunity to do something about their concerns for science education, they volunteered to participate in planning and conducting the CRCM Academy.

The purpose of the study was to examine, qualitatively, the personal development of the four college science professors in conducting this type of science academy for teachers. Also noted and observed were any changes in their views of science, science education, and teachers, as well as the impact, if any, on the science professors. A review of literature revealed articles about science professors conducting in-service workshops. Such articles typically focused on the scientific expertise made available to the teachers (e.g., Barinaga, 1991). However, the search of the literature showed no research on what happens to science professors as they interact with teachers during inservice training. This is a virgin field for research. In our view, this is vital information if education expects to involve science professors in teacher education on a consistent, long term basis.

The Procedures of the Study

The four professor were interviewed before, during, and after the academy with one exception. The first structured interview (See Appendix A) focused on the professors' backgrounds, their views of science and science education, and their perceptions of teachers. The mid-term interview was conducted at the approximate midpoint of the academy. Its main focus was to solicit the instructors' views of how things were going in the academy. The final interview focused on the professors' evaluations of the academy, their views of science education, teachers, and science. The research team included questions designed to elicit comments concerning changes that might have occurred during the academy along with the professors' reactions to teachers.

The interviews were audio taped and transcribed. After transcription, the text of each interview was analyzed by attaching descriptive codes to units of information or chunks of meaning (Strauss, 1987). The codes were taken from the text itself and the mechanical processes of attaching codes to text and of sorting codes was done by computer (Seidel, Kjoleseth and Seymour, 1988). The coding was first done by the research team members working individually. The team subsequently met as a group and came to consensus on a final set of codes and the application of those codes on the transcripts. A list of the codes is provided in Appendix B.

Having reached consensus on coding, the research team set five questions, based on the research purpose, for organizing and analyzing the transcripts:

1) Who were the professors?
2) What was their view of science before and after the academy?
3) What was their perception of K-12 education?
4) What were the new skills and knowledge needed to be an academy instructor?
5) How did their view of teaching change?

The research team then decided which codes pertained to each of the questions, and then pulled all of those coded sequences. The sequences were reviewed by question and all salient comments were highlighted. On the basis of the highlighted text, the research team decided to focus on three broad areas: preparation for the academy, what happened during the academy, and changes of thought experienced by the professors. A narrative was written based on the transcripts and focusing on these three areas. For the purpose of reporting each professor was given a pseudonym: Jefferson, Stevenson, Collins, and Michaels. As the reader begins the narrative it is important to note that the academy was a success in terms of how well it was received by the teachers and in terms of classroom change base on the academy (Cobern, Zambo, & Fedock, 1992).

Preparation for the Academy

When the research team first met with the professors they talked with them about their role in the academy, and interest and goals for the academy. The professors agreed that, in the words of one professor, their role was "to impart to teachers or to empower them with some additional scientific content, and to make it easier or facilitate their ability to teach biology". The professors were excited about being in the academy for different reasons. One professor was excited because of her background in education.

> **Collins**: I teach a non-majors course and many of them are going into elementary education so I've been dealing with sort of a pre-service aspect of things... and interested about the quality of science education in the elementary school. I am excited about doing it, I have been wanting to [to do something like this]..., my background to a certain extent is in education.

Michaels simply commented, "I was excited about doing it because it is something new for me."

The sources of their interest as instructors for the academy varied greatly. For example:

> **Collins**: I originally intended to be a high school teacher and went through the California certification program ... teaching has always been an interest of mine and that is why I am at the community college [rather than at a university].
>
> **Jefferson**: Just to see sort of what is going on at this K-12 level. I am interested just from teaching introductory biology where the students seem to lack much interest in biology.
>
> **Stevenson**: It's my connection with Bill Cobern [a science education professor] that got me interested in it and it really comes from the fact that the quality of the students that we're getting is declining.

Along with their excitement, enthusiasm, and interest, there was also apprehension. Again the sources varied. Most were apprehensive because they were intending to employ a new teaching strategy. They were apprehensive about their lack of experience with teachers. They were apprehensive about their lack of school knowledge including the lack of school vocabulary and jargon. All four professors had personal goals for participating in the academy. For one it was "to see if there is something I can learn from it." For another it was to gain "a better understanding of what's going on in the 7-12 grades, and why students lose interest in biology." Others wished to give teachers more hands on experience with science. All agreed with the view of one professor, that by working with teachers "I am strengthening the students that I'm ultimately going to see as college students."

Of course as scientists the professors had their own view of what science is. As teachers of science they had their own view of how it should be taught. These views were based on their personal experiences first as students of science and then as teachers of science. In addition, three of the professors had family members in school, be it niece, nephew, or their own off spring, from whom they had gained some experience with school science. All the professors could remember bits and pieces of science in high school. Primarily what they remembered was science taught in a lecture and lab format. Professor Collins admitted that she did not come to a good understanding of the processes of science until she was in graduate school. All four professors believed that teaching content in science is the critical component to understanding science. In fact, the initial brochure that the professors designed to

advertise the academy among teachers stated that the academy was content driven using a biology textbook with assigned readings and tests.

On reflecting about their own experiences with science at the elementary level they remembered little time being spent on science. One professor commented that any science that was taught was actually "the teaching of health" which the teacher called science. Stevenson, Michaels, and Collins spoke of experiences that their own children, nieces or nephews had in elementary science education. They sensed a difference between their own personal experiences in elementary school and what they perceived to be happening in schools today. Their perception was that science at the elementary level is changing for the better but more needs to be done. Their opinion that more needs to be done with school science was strongly associated with their judgment that their own students are poorly prepared for college level biology. In their view, the college problem stems from a poor preparation in science content provided by the elementary schools and high schools.

Professors Collins and Michaels had charge of the elementary section of the academy. As noted above they considered science content to be the critical element in science education, and though they found elementary science education to be rather bookish, they were not pleased with what they saw as the results. In Collins opinion, teachers have their students read the book, memorize facts, and give back the correct answers. In her view teachers teach science as vocabulary and terms, and commented on "how uninteresting this would be to the students."

> **Collins**: The textbook approach turns kids off and gives them the wrong idea about what science is all about.... they think there is no creative thought involved in science ... the whole notion of doing experiments never crosses their minds.

Michaels agreed with Collins' views but added that he thought science teaching at the elementary level might be changing. This view was based on his own children's experiences in school. His oldest child who is now in her late teens had a much different experience with elementary school science than his two younger children. The two younger children are currently in second and third grade and appear to be having a much better experience with science than did their older sister. The teachers for the younger two use a more thematic and process oriented approach to science. Michaels gave specific examples of how science was taught to his younger children, but was unsure whether their teacher represented an exception or a new rule in

elementary school science. He was concerned that "science teaching depends on the interest of the teacher."

Collins and Michaels agreed that the lack of science at the elementary level must largely be due to the teachers' lack of scientific knowledge in science, and secondly to the lack of necessary science materials and equipment. They also believed that teachers do not have a very positive attitude toward teaching science, in part, because it is not an elementary school priority.

> **Collins**: Teachers don't have laboratories and they don't have materials for them to do hands-on sciences or the teachers say " Open your books and we're going to look at this, read it ... if you got the right answer in the book that's all that matters.

> **Michaels**: Science teaching depends on the interest of the teacher ... many equate science with health and the student misses out on a lot of things that they could be exposed to.

Even though both professors philosophically felt that content was the critical element in the teaching of science, they had learned from experience and observations at the elementary level that content driven science can be uninteresting and ineffective. Their main concern for the teaching of science at the elementary level was thus to increase teachers' content knowledge while providing an alternative approach to teaching.

Stevenson and Jefferson had charge of the secondary section of the academy. They too had opinions about students and what occurs in the schools.

> **Jefferson**: High school students are so driven by their hormones... then the teacher says "OK, this week we're going to talk about genetics." A lot of them would turn off, "Oh, I don't want to learn about that, I hate it..." Give them practical examples!

They believed that secondary teachers have good science backgrounds but felt that teachers needed to teach more content. Again, this view was based on the professors assessment of the quality of student that they see in their own introductory courses. Thus, the professors' interest in the academy was to do something to help improve the quality of their own students, primarily in terms of student understanding, knowledge, and preparation for college biology. The professors viewed the lack of content knowledge as the primary problem needing to be addressed at the elementary and secondary levels. Thus, their solution was a content driven academy for teachers.

As stated earlier, in their initial plans a biology textbook was to be the center of the academy with specific readings and tests.

As part of the professors' preparation for the academy they read widely in the literature of science education. They read reports on the status of science education in the United States, reform documents, science education research articles, articles from Science and Children and The Science Teacher. They read articles recommended to them as well as articles found through an ERIC search. They observed in classrooms, consulted with experts in science education, and worked with teacher mentors. The four teacher mentors were outstanding elementary science teachers selected by their district to assist the college professors in the planning and implementation of the academy.

After careful examination of the literature, analysis, and discussion with various people in the field, the professors choose to base the instructional methods used for the academies on the learning cycle (Lawson, Abraham, & Renner, 1989) and cooperative learning (Johnson and Johnson; 1992, 1987). This decision was a source of a certain amount of apprehension because they were not familiar with this method of teaching. However they all felt that this was the method of choice based on their investigations. Once the learning cycle and cooperative learning strategies were identified as the methods of instruction, the professors and mentors developed the specific activities to be used in the academy. The mentors and the professors met on a regular basis and selected, designed or developed topics, themes and activities. The professors found the mentors to be critical in planning and implementing the academy. The mentors' experience with both the learning cycle and cooperative learning strategies, as well as their experience in K-12 education made them a vital coponent of the planning process. The professors relied heavily on the mentors because in fact they were exemplary science teachers and acted as sounding boards in the exchange of ideas and discussion. The professors commented that "we couldn't have generated and gotten the academy going without them", "they had the process background", "I learned so much from them," and "it's exciting to see real teachers turned on to science."

What Happened during the Academy

The secondary section of the academy began the first week in June 1992. The elementary section of the academy began the first week in July 1992. The venue for this first section was a lecture hall and a science laboratory at the community college. Stevenson and Jefferson divided the academy in half and used a turn-teaching

approach. Stevenson taught the first two and one-half weeks and Jefferson the last. They implemented the learning cycle with a rather typical college lecture format followed by an inquiry and cooperative learning laboratory session based on the lecture material. When one professor was lecturing the other would assist with demonstrations and laboratory activites along with the two teacher mentors.

Almost immediately the professors were faced with something unexpected. Stevenson commented, "I was surprised that the teachers questioned my knowledge base." Apparently a small group of teachers were not convinced of the professors' knowledge and pressed them by asking many questions in a rather pointed fashion. Based on the academy evaluation (Cobern et al., 1992) the teachers apparently satisfied themselves that the professors' content knowledge was sound.

As the academy progressed, the professors were pleased with the learning cycle and the effectiveness of cooperative learning. Both professors commented that using the learning cycle complemented the hands on laboratory activities. The learning cycle created more discussion than in their regular community college classrooms. Both professors saw this as advantageous. Jefferson's words, "It keeps teaching a lot more interesting." As noted above, Stevenson and Jefferson combined the learning cycle with a traditional lecture approach. Due to this design they did not have the variety or amount of interaction with the teachers that occurred in the elementary academy. This difference was not lost on Stevenson and Jefferson. Midway through the academy, the professors were already thinking of ways to modify and change the academy.

> **Jefferson**: There is not much communication going on....they haven't worked well together, maybe if I interact with them more we could work together. If we were to do things over or different we either would try to do them where the lab activity, the exploration comes first, and then go back and do the content.
>
> **Stevenson**: If we were to do this academy again we need to have separate academies for the middle school and high school teachers.

The secondary section of the academy ended the first week of July 1992. The lessons of the first section were put to good use in the elementary section of the academy. Collins and Michaels felt they had a big advantage over the professors teaching the secondary section since they had the opportunity to observe the first section. Partly in response to these observations and their mid-term discussions with the first section professors, Collins and Michaels decided on a significantly different format for using the learning cycle and cooperative learning strategies. They decided

not to use a lecture format with a separated lab, but to employ a unified approach. The teachers were encouraged to explore materials. They were given bits of information and then encouraged to further explore, again followed with more information. Collins and Michaels also created a different physical environment. They held class in a large room with large tables so that teachers could sit and work in cooperative groups the entire time the class was in session. Moreover, they decided to take a thematic approach to science by integrating other curriculum areas. The teachers' projects and work were displayed around the classroom. In other words, the elementary section of the academy was set up like an elementary classroom. In the spirit of cooperative learning the professors taught cooperatively.

During the elementary academy both professors expressed excitement about their interactions with the teachers. Both professors commented on the enthusiasm and acceptance by the teachers and how the teachers embraced the learning cycle. Early on the teachers voiced concerns about the lack of science materials for their classrooms. In response to their concern the professors modified their activities with low cost and easily available materials. Reflections on their own teaching style was revealed by the professors teaching the elementary session. One professor was pleased with how well the learning cycle worked and commented " it makes science more interesting and fun." The professors both commented on how effective they felt the learning cycle was and how they both enjoyed teaching following the learning cycle format. One professor had an "Ah Ha" experience during the academy. Collins discussed seeing the importance of high level questions because it is the link for application. The other professor commented " I am going to take some of the lessons that we did teach process skills and do it with my students in class.

Changes of Thought Experienced by the Professors

As noted, the decision to use a learning cycle and cooperative learning strategies was the source of a certain amount of apprehension. The apprehension diminished early for all four professors. The professors made comments such as,"the teachers are really responsive to us," "the learning cycle really works," "the teachers seem eager every day," and "I am enjoying myself." The professors initial apprehensions stemmed from their unfamiliarity with both teachers and the teaching strategies they chose for the academy. What they discovered to their relief was that the teachers were relatively easy to work, they were flexible, and open to new ideas. Moreover, they found that the learning cycle and cooperative learning strategies not

only were effective for teaching science but also engendered considerable enthusiasm.

As also noted the professors began the academy with a particular view of science and importance of content in science. By the end of the academy the professors appeared to have undergone two major changes of thought. First the professors had a dramatic change of view concerning how science can and should be taught at the introductory college level. As a result the professors have since the academy modified their general biology course at the community college level. They dropped the traditional lecture and lab format and adopted the learning cycle and cooperative learning strategies used in the academy. In addition they also decided to use many of the activities they had developed for summer academy in their community college courses.

> **Collins**: I am changing the lab structure a little bit so instead of meeting once a week for three hours, we are meeting twice a week for an hour and a half... we will use more of the academies activities...
>
> **Stevenson**: the labs are being revamped to fit the learning cycle...
>
> **Michaels**: I am doing much more exploration, and it has changed not only me, it has changed the biology department... First week, instead of just going in and start lecturing, we were asking the students to get together in groups and answer the question, "What do scientists do?

After the first week of the college fall semester, the professors noted positive changes in their courses. They were particularly impressed by the increased amount of class discussion. They found that their new strategies, in the words of one professor:

> **Michaels**: broke the ice for participation in the classrooms immediately instead of the usual 3 to 5 weeks... the students were answering and asking questions early in the semester.

One professor made the comment that he had never heard a student say on the first day of class that this will be a really interesting class. Moreover, the professors noted a lower level of anxiety among their students at the end of the first week. In light of these successes, the professors began a departmental discussion on long range plans to revamp the general biology courses. Clearly the professors had enthusiastically embraced learning cycle and cooperative learning strategies.

In addition to a changed view of teaching science, the professors also seemed to have a new way of viewing science. For them the academy was;

> a refreshing experience... revitalizing... this is what science is all about...
>
> it brought new enthusiasm to my teaching
>
> I did not have the perception that one could integrate science across the curriculum...
>
> the learning cycles has helped... because it changes our perception on how we communicate with students with respect to science.

The professors were surprised how their view of science had been broadened. In the words of one professor,

> **Michaels**: I never saw science as integrating with other facets of life, I had a very narrow perspective of science, being a cell biologist, but my perspective has broadened greatly and I am amazed.

Summary Remarks

In light of this new view of science, the professors now see themselves as part of the problem in science education. Initially they felt the elementary and secondary schools were lacking in the teaching of scientific concepts. The professors, after experiencing success and change in the academy, now feel, they are an integral part in the development of students perceptions of science, attitudes toward science and in the understanding of scientific concepts. In part, because of this new view of science they need to be teaching in a fashion that is also motivating and nurturing of positive attitudes towards science. With renewed enthusiasm these professors now look forward to meeting the challenge in science education.

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Appendix A

Pre-academy interview questions

Have you ever been a part of a summer program for school teachers before now?

Tell me about your thoughts and feelings when you were first asked about teaching a summer academy for teachers?

Why are you participating?

Tell me about your role in this academy?

What do you understand are the official goals of the science academy?

Do you view these goals as responsive to the needs of teachers?

Do you have goals of your own in addition to the stated goals?

How much do you know about sec/elem education in general?

Tell me how you think science is taught in the schools?

How would you describe a typical lesson in sec/elem science?

What do you think is the attitude of sec/elem teachers toward science?

What are your impressions of the quality of sec/elem science teaching?

How well do you think teachers are doing? Explain.

Do you think there is a need for academies like this? Why?

What do you think public school elementary teachers and high school teachers need to know to become better science teachers?

Will this academy prepare teachers to address the Arizona Essential Skills for Science?

Tell me about how you have been preparing for the academy?

Tell me about any concerns you may have about your personal involvement in an academy for teachers?

Appendix A

Mid-academy interview questions

How do you think the academy is going at the present time?

What have you found to be the most effective teaching strategy to use with these teachers?
am/pm

The least effective? am/pm

Have you made any adjustments or changes in the format?
What is the change?
What made you think you needed a change?
What was the impact of the change? am/pm

Have you found that the meeting area (rooms) has had an effect on what you're doing in terms of daily activities? am/pm

How have the mentors impacted the academy?
in terms of planning?

in terms of implementation?

What was your opinion of project wild?
appropriate material for HS teachers?

from the view of a professional biologist?

At this point in time, do you have any personal concerns about your personal involvement?

In light of the past few weeks of experience with secondary teachers, what is your perception of secondary teachers now?

How do you feel about your involvement right now in this particular academy?

In this general type of program?

Appendix A

Post academy interview questions

How do you think it went?

Now that you have finished the academy, what are your thoughts on secondary (elementary) school teachers?

Now that you have finished the academy, what are your thoughts on secondary (elementary) science curriculum?

What do you feel you accomplished?

As a college professor, what was the most difficult thing for you to do?

As a college professor, what was the easiest thing for you to do?

Before the academy started you had some concerns, do you remember any of your concerns actually being a problem?

Has the academy changed the way you will teach at the college level?

Having done the academy, do you see yourself as having a role to play in the support of teachers teaching science?

What is that role?

What do you see yourself doing in the future?

Appendix B

Lexicon for the Coding of the Professors' Comments

Exper:	professors' personal experience with teaching, teachers, children, schools, at college, etc
Interest:	professors' own interest in teacher education and enhancement
Role:	professors' view of their role in the academy
Content:	specific reference to discipline content in the academy or their own teaching or as an instructional objective
Vtchrs:	non judgmental view, beliefs, or opinions of teachers
Method:	specific instructional methods used in the academy
Goals:	academy or professors' personal goals
Minor:	teacher or professor reference to minority issues
Gender:	teacher or professor reference to gender issues
Know:	professors' knowledge of schooling including what they "think" they know
Mentors:	specific mention of the mentors role or activities at the academy
Vtchg:	non judgmental view, beliefs, or opinions about teaching and approaches to teaching
Comcol:	reference to support by or relations with community college
Admin:	reference to support by or relations with school administrators
Appre:	professors' feelings of apprehension
Excite:	professors' feelings of excitement
Prep:	professors' preparations for the academy
Lit:	professors' use of literature in preparation for the academy
Team:	professors use of team work preparing for and during the academy
Expert:	professors use of experts in science education preparing for and during the academy
Leader:	role of leadership preparing for and during the academy
Need:	teachers' perceived need for this type of academy
Complt:	specific teacher complaints made about the academy
Problem:	professors' perceptions of problems at the academy

Eval:	valuative comments about the academy
Interact:	specific non-complaint interactions between professors and teachers, must have specific teacher comment
Science:	remarks about what science is
Change:	any change with the professors including learning
Frust:	professors' expression of frustration
Stress:	professors' expression of stress
Room:	specific reference to the room and facility in which the academy was held
Inquiry:	specific reference to inquiry approaches to science teaching such as the learning cycle, science process, exploration
Observ:	professors visits to classrooms for observation
PW:	reference to Project Wild
GCCSS:	reference to GCC students
Material:	reference to materials needed by the teachers to implement the academy lessons
EEI:	essential elements of instruction
Network:	interaction between teachers or teachers and professors after the academy, or requests for materials